IN THE UNITED STATES DISTRICT COURT
FOR THE WESTERN DISTRICT OF TEXAS
WACO DIVISION

WSOU INVESTEMENTS, LLD D/B/A BRAZOS LICENSING AND DEVELOPMENT, *Plaintiff*, v. **CANON, INC.**, *Defendant*.	**6:20-cv-00980-ADA**
CANON, INC., *Third-Party Plaintiff*, v. **NXP USA, INC.**, *Third-Party Defendant*.	**6:20-cv-00980-ADA**

DECLARATION OF DR. ZHI DING IN SUPPORT OF
CANON'S PROPOSED CLAIM CONSTRUCTIONS

I. INTRODUCTION

I, Dr. Zhi Ding, declare as follows:

1. I have been retained by counsel for Canon Inc. in the above-captioned action as an independent expert consultant to offer opinions regarding how a person of ordinary skill in the art ("POSITA") would understand certain claim terms in U.S. Patent No. 7,054,346 (the "'346 patent").

2. I am informed that the parties have proposed the following constructions for the claim terms listed in the table below:

Claim Term	Canon's Proposed Construction	WSOU's Proposed Construction
"a time period T" / "[at least] a portion of the time period T" (claims 1-4, 7, 11, 13-16, and 19)	"T is a pre-set amount of time for one cycle of frequency hopping, which is no longer than the amount of time it would take to use each channel available for frequency hopping once," otherwise indefinite.	Plain and ordinary meaning; or, if the court deems a construction is necessary: "a period of time T" / "[at least] a portion of the time period T"

Claim Term	**Canon's Proposed Construction**	**WSOU's Proposed Construction**
"a set of N frequencies"/ "a size of N/F frequencies" / "a set of F frequencies" / "a set of hopping frequencies" / "a hopping set" / "a hopping set to a size of N/F frequencies" / "a hopping set comprising N/F frequencies" / "where N is the total number of frequencies available for frequency hopping" (claims 1-4, 7, 11, 13-16, and 19)	"N frequencies" / "a set of hopping frequencies" / "a hopping set" are "a pre-configured number of distinct hopping frequencies to which the hopping constraining algorithm is applied and which must not be selected more than once over the time period T," otherwise indefinite. "a size of F frequencies" / "a set of F frequencies" / "a hopping set to a size of F frequencies" / "a hopping set comprising F frequencies" are "for a time period T, the number of remaining frequencies available for frequency hopping that have not been previously selected during that time period", otherwise indefinite	Plain and ordinary meaning.
"at least one of the selected frequencies is prohibited from subsequent selection" (claims 1-4, 7, 11, 13-16, and 19)	"a frequency that has already been used during the time period T is prohibited from being re-used during the remainder of the time period T solely because it has been previously used"	Plain and ordinary meaning; or, if the Court deems a construction is necessary: "at least one of the selected frequencies is not allowed to be subsequently selected"
"pseudorandom[ly]" (claims 1-4, 7, 11, 13-16, and 19)	"a selection generated by an algorithm that approximates a random selection by avoiding a regular pattern of selections when the algorithm is used repeatedly"	Plain and ordinary meaning; or, if the Court deems a construction is necessary: "appears to be patternless"

3. I have been asked to opine on how a POSITA would understand each of these terms as used in the '346 patent with the exception of the term "a frequency that has already been

used during the time period T is prohibited from being re-used during the remainder of the time period T solely because it has been previously used."

II. QUALIFICATIONS

4. I am an expert in the field of wireless communication systems, including those that use frequency hopping, with over 31 years of research and practical experience in the field. I presently serve as a Distinguished Professor in the Department of Electrical and Computer Engineering at the University of California, Davis (UC Davis). Since my appointment on July 1, 2000 at UC Davis, I have held the position of Professor. I am also a private technical consultant on various technologies related to information systems. I have over three decades of teaching and research experience on a wide range of topics related to communication systems and signal processing.

5. I earned my Bachelor of Engineering degree in 1982 in wireless engineering from the Nanjing Institute of Technology (later renamed as Southeast University) in Nanjing, China. I earned my Master of Applied Science degree in 1987 in electrical engineering from the University of Toronto in Toronto, Canada. I earned my Ph.D. in 1990 in electrical engineering from Cornell University in Ithaca, New York.

6. My responsibilities as a Professor at University of California, Davis, include classroom instruction on various topics of communication systems and signal analysis, as well as mentoring undergraduate students and supervising graduate students in their research and development efforts on various topics related to digital communications. I have directly supervised such research and development works ranging from signal detection to wireless networking. A s the chief academic advisor, I have also directly supervised the completion of over 20 Masters theses and 30 Ph.D. dissertations on various topics related to digital

communications. I have served full time as a faculty member as a Professor of Electrical and Computer Engineering at three major research universities in the United States over the past 30 years, including Auburn University from 1990 to 1998, University of Iowa from 1999 to 2000, and University of California, Davis, from 2000 to the present.

7. Since 1990, I have been selected as the principal investigator of multiple highly competitive federal and local research grants, including sixteen major research projects supported by the National Science Foundation and two research projects funded by the U.S. Army Research Office. These competitive research projects focused on developing more efficient and effective digital communication transceivers, networks, and signal processing tools. I have also participated as co-principal investigator in several large-scale projects supported by the Defense Advanced Research Projects Agency (DARPA) with teams of researchers. Additionally, I have applied for, and received support from, other federal, state, and industry sponsors.

8. I have published over 200 peer-reviewed research articles in premier international journals, in addition to over 240 refereed technical articles at top international conferences on communications and information technologies. In addition to these peer-reviewed technical works and book chapters, I have also written two books on communications technologies. My most recent book, coauthored with B.P. Lathi, is entitled, “Modern Digital and Analog Communication Systems,” 5th edition, and was published by the Oxford University Press in 2018. The 4th edition of this book (also coauthored with B.P. Lathi and published in 2009) had been widely adopted as an introductory textbook to communication systems.

9. In addition to the over 440 published technical papers that have been cited over 14,000 times according to Google Scholar, I am also co-inventor of 4 issued U.S. patents on communication technologies.

10. I am a member of the Institute of Electrical and Electronics Engineers (IEEE) and was elevated to the grade of Fellow in January 2003 for contributions made in signal processing for communication. The IEEE is the world's largest professional society of engineers, with over 400,000 members in more than 160 countries. The IEEE has led the development of many standards for modern digital communications and networking, most notably, the IEEE 802 series of network standards. The IEEE Grade of Fellow is conferred by the Boards of Directors upon a person with an extraordinary record of accomplishments in any of the IEEE fields of interest. The total number selected in any one year does not exceed one-tenth of one percent of the total voting Institute membership. In 2012, I received the annual Wireless Communications Technical Committee Recognition Award from the IEEE Communications Society, an award given to a person with a high degree of visibility and contribution in the field of "Wireless and Mobile Communications Theory, Systems, and Networks." In 2020, I am the recipient of the annual Education Award from the IEEE Communication Society.

11. I have also served as a technical consultant for the telecommunication industry. For example, in 1995 I consulted for Analog Devices, Inc., on the development of the first generation DOCSIS cable modem systems. I have also consulted for other companies, including Nortel Networks and NEC US Laboratories. I worked as a visiting faculty research fellow at NASA Glenn Research Center in 1992 and at U.S. Air Force Wright Laboratory in 1993. I have served on multiple review panels of the National Science Foundation to evaluate competitive research proposals in the field of communication. I have also reviewed a large number of

research proposals at the request of the National Science and Engineering Research Council (NSERC) of Canada as an expert panelist from 2010 to 2013, and also at the request of the Research Grant Council (RGC) of Hong Kong as an external reviewer.

12. I have served as an expert witness or consulting expert on a number of matters related to intellectual property, mostly in the arena of telecommunications, including cellular communications, Wi-Fi technologies, Bluetooth, and optical communications. For example, since 2007, I have been engaged to assist in various litigations and legal disputes involving cellular, WiFi, and optical communication networks in terms of essentiality, infringement, and invalidity.

13. Other details concerning my background, academic work, and professional history are set forth in my curriculum vitae, which is attached as Ex. A to this declaration.

III. COMPENSATION

14. I am being compensated for my services in this matter at my standard hourly rate for consulting services. My compensation is not contingent upon the opinions I render or the outcome of this litigation.

IV. MATERIALS CONSIDERED

15. In preparing this declaration, I reviewed and considered the following materials, as well as any others referenced in the body of my declaration:

- The ’346 patent, its prosecution history, and the Kung, Emi, Munday, and Haartsen prior art references cited therein;
- ETSI TS 145 002 V.4.3.0 (2001-04), a.k.a. 3GPP TS 45.002, “3rd Generation Partnership Project; Technical Specification Group GERAN; Digital Cellular telecommunications System (Phase 2+); Multiplexing and Multiple Access on the Radio Path (Release 4)”;
- The American Heritage College Dictionary (2000) definitions of “pseudorandom” and “random”; and

- Webster's II New College Dictionary (2001) definitions of "pseudorandom" and "random."

16. I may use these documents and information, or other information obtained during the course of this or related proceedings, as well as representative charts, graphs, schematics and diagrams, animations, and models based on those documents and information, to support and to explain my opinions. I am informed that discovery in this action has not yet begun and I reserve the right to modify or supplement my opinions, this declaration, and/or to submit additional declarations to address any information obtained, or positions taken.

17. My opinions are based in part on a review and analysis of the above-mentioned documents and materials. I have also drawn on my education, experience, and knowledge of basic engineering principles, foundational knowledge in mathematics and physics, basic software and hardware design principles, fundamentals of communication systems and networking, including spectrum sharing and frequency hopping systems and components thereof.

V. LEGAL STANDARD

18. I am not a legal expert or an attorney, and offer no opinions on the law. I understand that claim construction is a matter of law. However, I have been informed by counsel of the legal standards that apply to claim construction, and I have applied them in forming my opinions.

19. I have been informed that the words of a claim are generally given the ordinary and customary meaning that the term or phrase would have to a POSITA at the time of the invention in view of the surrounding claim language, the specification and the file history (collectively, the "intrinsic evidence"). I also understand that courts may consider extrinsic evidence, such as expert and inventor testimony, dictionaries, and learned treatises, but that such extrinsic evidence should be given less weight than the intrinsic evidence.

20. I have been informed that a term must be interpreted with a full understanding of what the inventors actually invented and intended to include within the scope of the claim as set forth in the patent itself. Thus, claim terms should not be broadly construed to encompass subject matter that is technically within the broadest reading of the term but is not supported when the claims are viewed in light of the invention described in the specification. I have also been informed that when a patent specification repeatedly and consistently characterizes the claimed invention in a particular way, it is proper to construe the relevant claim terms in accordance with that characterization.

VI. LEVEL OF SKILL IN THE ART

21. I am informed that WSOU asserts that the priority date for the '346 patent is May 7, 2001. I have been instructed by counsel for Canon to use that priority date in forming of my opinions herein and have done so. I understand that factors such as the education level of those working in the field, the sophistication of the technology, the types of problems encountered in the art, the prior art solutions to those problems, and the speed at which innovations are made may help establish the level of skill in the art.

22. I find the pertinent art for the '346 patent to lie generally in the field of frequency hopping for wireless communications in a shared access scenario. Based on my review of the technology, the educational level in the field, and drawing on my own experience in the field, it is my opinion that a POSITA in the timeframe of WSOU's alleged May 7, 2001 priority date would have had a Bachelor's degree in an accredited program of Electrical Engineering, Computer Engineering, or in a similar discipline, and have 3-4 years of practical work or research experience with specialization in the general field of wireless communications and

networking. More advanced degrees and/or training in a related discipline can compensate for shorter work experience.

23. At all relevant times, I have exceeded the qualifications of a POSITA. By May 2001, I had already earned my Ph.D and had been conducting state-of-the-art research and teaching university courses on the pertinent technologies for over 10 years. Notwithstanding that I exceeded the qualifications of a POSITA, I have formed my opinions from the perspective of a POSITA.

VII. TECHNOLOGY BACKGROUND

24. The technology of the '346 patent relates to frequency hopping in wireless systems. By May 2001, textbooks had been written about frequency hopping. The field was already well developed and it was already commonplace to use frequency hopping to mitigate the effects of non-ideal conditions such as channel distortions, noise, and interference that standards like the WiFi standard, the GSM standard, and the UMTS standard had been codified to tackle.

25. In particular, by May 2001, well known textbooks had been covering the technical aspect of frequency hopping for a number of years. For example, one of the best known textbooks by John G. Proakis (Digital Communications, published by McGraw-Hill Higher Education, 2000), had been updated into its 4th edition. The entirety of chapter 13 of the Proakis book provided details on spread spectrum communications and particularly, frequency hopping. The IEEE 802.11 WiFi standard published its frequency hopping physical layer specification in 1997. Its entire Chapter 14 had been dedicated to the "Frequency Hopping Spread Spectrum (FHSS) PHY Specification for the 2.4GHz ISM Band." Similarly, the GSM standard GSM

05.01 "Physical Layer on the radio path," published in May 1996, had fully disclosed the use of frequency hopping for channel access in its Chapter 6 "Frequency hopping capabilities".

26. If requested, I am prepared to explain at a technology tutorial or claim construction hearing the technology disclosed in the '346 patent, including the state of the art around the filing date of this patent. This may include, among other things, background information on channel distortions, interferences, how frequency hopping tackles such distortions and interferences, algorithms to implement frequency hopping in wireless systems, and the incorporation of frequency hopping in systems at the time of the '346 patent priority date. It may also include the use of visual aids or other demonstrations.

27. I am also prepared to rebut, as necessary, matters raised by WSOU – whether in declarations, reports, depositions, or hearings – and to address related matters raised in the course of claim construction.

VIII. SUMMARY OF THE '346 PATENT

28. The '346 patent explains that it relates to a very specific system and method of "frequency hopping for communicating signals in a wireless communications system" where, "[o]ver a time period T, [a] wireless endpoint performs pseudo-random selection of a frequency from a hopping set such that over at least a portion of the time period T the choice of frequencies to select from within the hopping set is constrained as a function of previously selected frequencies" so that "prior selected frequencies are temporarily prohibited from being selected again from the hopping set." '346 patent at 2:37-47.

29. A POSITA reviewing the intrinsic evidence would have understood at the time of '346 priority date that the patent is about this specific system and method because that is what the patent owner consistently said, for example in: (1) what they admitted was known in the

prior art in the specification background; (2) their discussion of the problem they were attempting to solve; and (3) their claim amendments and discussions of the prior art references they were attempting to overcome through these amendments when the patent was prosecuted.

A. The Admitted Prior Art in the '346 Patent

30. In the Background of the Invention section of the '346 patent specification, the patent owner admits that pseudorandom frequency hopping in wireless systems was commonly done by prior art systems in a crowded field. They also admit that the prior art extensively discussed using frequency hopping to alleviate interference, fading, and other similar issues. This is consistent with my understanding of the field, as I explained above in the Technology Background section. In fact, as the '346 patent admits, these techniques were so well known that all wireless devices using the GSM standard already used them. I agree with the '346 patent's conclusion that "[t]he pseudo-random frequency hopping algorithm specified in GSM provides interferer diversity and achieves long-term interference averaging." '346 patent at 1:55-57; *see also* 1:33-36 (GSM frequency hopping "mitigate[s] the effects of slow fading and interference" and "provides the following benefits: fading diversity, interferer diversity, and interference averaging")).

B. The Problem the '346 Patent Attempted to Solve

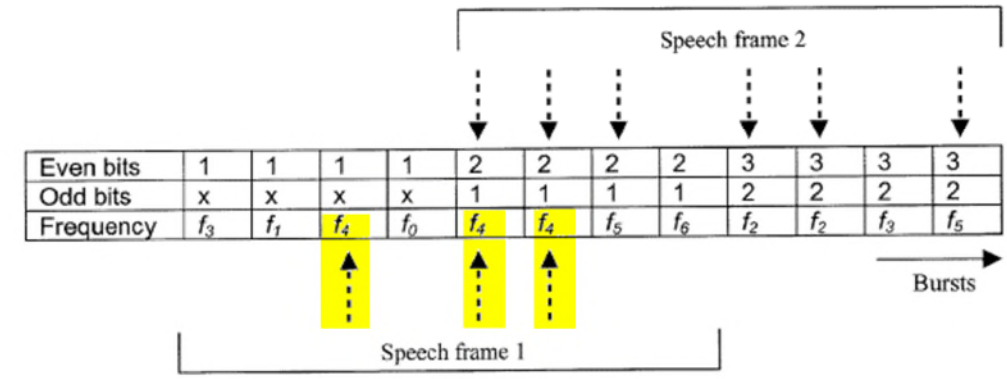
31. The '346 patent admits that using pseudorandom frequency hopping to avoid interference was well-known in the prior art and raises only the complaint that prior art systems were "typically non-ideal" and "not fully realized." *Id*. at 1:37-39. Specifically, the patent owner acknowledges that "[t]he pseudo-random frequency hopping algorithm specified in GSM provides interferer diversity and achieves long-term interference averaging," but complains that it does not "***guarantee fading diversity (i.e., no frequency repetitions) within the interleaving***

depth of a speech frame." *Id*. at 1:55-59. I note that the '346 patent itself acknowledges that this was not even an issue in general, because "if a large amount of spectrum is allocated, then there are many frequencies over which users can hop and repeated frequencies over a short interval are not common." *Id*. at 1:60-63.

32. The '346 patent states that during particular transmission scenarios, it is possible that some frequencies might be used more than once and others might not be used at all. The patent's example of this is Fig. 1, which shows a situation where frequency f_4 is selected three times in speech frame 1, with each of the three selections of f_4 in frame 1 highlighted in yellow, and frequencies f_2 and f_7 are not selected at all during that frame. *Id*. at 1:63-2:10, Fig 1:

FIG. 1

Prior Art



33. The '346 patent says that this example situation is a problem, because due to the small number of frequencies available for selection, the "pseudo-random frequency hopping algorithm does not maximize the number of unique frequencies" which the patent says can lead to "channel fading conditions" or "degradation in error performance." *Id*. at 2:15-26.

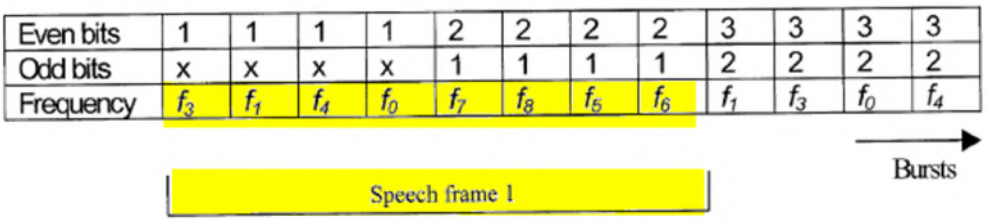
C. The Solution the '346 Patent Provides

34. The '346 patent says that it has solved the problem discussed in the previous section by using a pseudorandom frequency hopping algorithm where "[o]ver a time period T …

the choice of frequencies to select from within the hopping set is constrained as a function of previously selected frequencies. In particular, prior selected frequencies are temporarily prohibited from being selected again from the hopping set." *Id.* at 2:39-46. In other words, the '346 patent says its solution to what it describes as a problem in GSM is an algorithm that prevents a frequency from being repeated in a channel cycle.

35. The patent owner provides a couple of examples of this algorithm. In one, "if the total number of frequencies, N, in a hopping set is equal to 4, the hopping sequence is constrained to prevent any repeats within a set of four bursts," with the hopping sequence, *i.e.*, the time period T, being the time it takes to execute four bursts. *Id.* at 3:38-46. Fig. 3 shows another example in which the hopping set N is equal to 8, which unlike the prior art example shown in Fig. 1, uses the disclosed "constrained hopping sequence" to prevent "the repetition of any frequency over 8 consecutive bursts," with all eight of the different frequencies selected during speech frame 1 highlighted in yellow without any repeat. *Id.* at 3:46-52, Fig. 3:

FIG. 3



36. As the patent explains, its algorithm prohibits each selected frequency from being re-selected during the remaining time of the cycle, which guarantees that there are no repeats, as shown in speech frame 1 of Fig. 3. In doing so, the patent explains that the ***reason*** for

prohibiting each selected frequency from being subsequently selected is precisely because they were previously selected.

FIG. 6

column 1 ↓

row 1 →

Burst Number	Hopping index	A	Compute Hop Frequency	H	F
--	--	--	--	$H = \{1\ 3\ 4\ 6\ 2\ 0\ 5\ 7\}$	$F = 4$
0	1	$A = \{1\ 3\ 4\ 6\}$	$H_{(1 \bmod 4)} = H_1 = 3$	$H = \{1\ 6\ 4\ 3\ 2\ 0\ 5\ 7\}$	$F = 3$
1	5	$A = \{1\ 6\ 4\}$	$H_{(5 \bmod 3)} = H_2 = 4$	$H = \{1\ 6\ 4\ 3\ 2\ 0\ 5\ 7\}$	$F = 2$
2	2	$A = \{1\ 6\}$	$H_{(2 \bmod 2)} = H_0 = 1$	$H = \{6\ 1\ 4\ 3\ 2\ 0\ 5\ 7\}$	$F = 1$
3	4	$A = \{6\}$	$H_{(4 \bmod 1)} = H_0 = 6$	$H = \{6\ 1\ 4\ 3\ 2\ 0\ 5\ 7\}$ $H = \{2\ 0\ 5\ 7\ 6\ 1\ 4\ 3\}$	$F = 0$, $F = 4$
4	1	$A = \{2\ 0\ 5\ 7\}$	$H_{(1 \bmod 4)} = H_1 = 0$	$H = \{2\ 7\ 5\ 0\ 6\ 1\ 4\ 3\}$	$F = 3$
•	•	•	•	•	•
•	•	•	•	•	•
•	•	•	•	•	•

Table Two

37. The '346 patent explains an implementation of its algorithm in detail with reference to Fig. 6 (copied above). The algorithm begins by subdividing eight (N) available frequencies (H) into two frequency sub-groups (A), both of which begin with equal size to include four (F) frequencies. Hopping set H (highlighted in yellow) and variable F (highlighted in red) are first initialized prior to the starting time of burst 0, as shown: "In accordance with the invention," H is "a vector of length N, where N is the total number of frequencies to hop over," and F "is the number of frequencies in H over which the wireless endpoint is constrained to hop." *Id*. at 3:57-65; *see also* 5:21-27, 5:42-44. Set A is "the set of F frequencies over which a wireless endpoint is currently allowed to hop." *Id*. at 3:64-4:2; *see also* 5:44-46. Set A is also initialized as shown above in green highlighting, so that set A starts with the frequency set {1 3 4 6} to cover the first four busts and then starts with the frequency set {2 0 5 7} for the next four bursts. As shown for the first four hops, each time a frequency is used, that frequency is removed from set A (with each removal highlighted in orange) and the value of F is decreased by

one (with each decrease highlighted in blue), until all four frequencies have been used, at which time A is empty and F is 0. *Id*. at 5:47-55.

38. This partitioning of the set H into two subsets and then alternating the subsets reflects a further refinement of the inventive idea, which not only prohibits any repeats within an 8 burst cycle, but also from one 8 burst cycle to the next. In other words, without this partitioning into two sub-sets, the last frequency chosen at the end of one cycle could be pseudorandomly chosen as the first frequency of the next cycle, which would be a repeat.

39. The ’346 patent’s algorithm works on cycles in which each of the available frequencies is selected no more than once. *See id.* at 3:38-46. Whether from the perspective of the 8 burst complete cycle or over the 4 burst sub-cycle, no channel can be selected more than once, because from the moment it has been selected, the algorithm prohibits it from being re-selected until after the cycle has ended. These cycles define a time period T over which the algorithm operates. To provide the advantages of the purported ’346 patent invention, the time period T must not be longer than the time period needed to select each frequency exactly once. Otherwise, if the time period T were longer than the amount of time needed to select each frequency once, there would necessarily have to be some frequencies that are re-selected during the time period T, and this would not solve the problem the ’346 patent algorithm was designed to avoid. For example, if there were three available frequencies {1, 2, 3}, but the time period T was 4 bursts long, either at least one of the three available frequencies would have to be selected more than once within the time period T, or the system would run out of frequencies and not be able to transmit on the last burst.

40. It is only by having this relationship between the time period T and the available frequencies that this “use of constrained frequency hopping allow[s] GSM pseudo-random

frequency hopping to achieve full fading diversity" and "maximize[] the number of unique frequencies that occur over the interleaving depth of a speech frame," "in accordance with the invention." *Id*. at 7:20-30.

D. The Prosecution History of the '346 Patent

41. I have reviewed the prosecution history of the '346 patent, which I summarize in relevant part below.

42. The original independent claims of the '346 patent application were broadly directed to frequency hopping generally. At first, they did not require that: 1) frequencies be selected pseudorandomly; or 2) previously selected frequencies be prohibited from being subsequently selected because they were previously selected. *See* May 7, 2001 initial submission of claims. These original claims were rejected over U.S. Patent No. 4,654,859 to Kung ("Kung") and U.S. Patent No. 5,541,954 to Emi ("Emi"). *See* May 20, 2004 Office Action.

43. After this rejection, the patent owner amended to claims to require "pseudorandom" frequency selection. *See* August 16, 2004 Amendment pp. 2-8. At the same time, it argued that the Kung reference did not show "pseudorandom" frequency selection because it "selects a frequency by cycling through an ordered frequency set in a predetermined fashion. In contrast, the present invention pseudo-randomly selects a hopping frequency." *Id*. It also argued that Emi did not show "pseudorandom" frequency selection because it disclosed "a frequency hopping scheme where a receiver counts errors it has received on each given frequency. If a total error count exceeds some metric, then the received frequency will be deemed unusable and an alternative, unused frequency will be substituted in its place…." *Id*.

44. The patent examiner then rejected these amended claims over U.S. Patent No. 5,337,221 to Munday ("Munday") and U.S. Patent No. 6,345,066 to Haartsen ("Haartsen"). *See* January 7, 2005 Office Action. I note that both Munday and Haartsen clearly disclose pseudorandom frequency hopping (*see, e.g.*, Munday at 2:64-3:2; Haartsen at 4:34-37).

45. The patent owner then amended the independent claim again, this time to also require that "at least one of the selected frequencies is prohibited from subsequent selection in at least a portion of the time period T." *See* April 5, 2005 Request for Reconsideration pp. 2-10. At the same time, it argued that "neither Munday nor Haartsen, taken separately or in combination, discloses or suggests [this claimed] prohibition on frequency selection." *Id*. p. 11. It continued: "after a set of frequencies is selected in Munday or Haartsen any frequency within the set can be re-selected without prohibition. Said another way, neither Munday nor Haartsen is prohibited from re-selecting a frequency, from a set of allowable frequencies, that has already been selected during a time period, T, as in the claims of the present invention." *Id*. pp. 11-12. The patent owner also made these same arguments in a Notice of Appeal. *See* April 5, 2005 Notice of Appeal pp. 17-18.

46. After these amendments, the claims were said to be allowed based on the patent owner's statement that they require "pseudorandomly selecting frequency from a set of N (total number of frequencies available) frequencies, where prior selected frequencies are prohibited from being selected again from the hopping set." *See* January 13, 2006 Notice of Allowance p. 2.

IX. INTERPRETATION OF THE CLAIM TERMS

A. The "Time Period T" Terms (All Asserted Claims)

47. On its own, the term "time period T" would not have had a definite plain and ordinary meaning to a POSITA at any time, including in 2001. This is because the term is nothing more than an undefined variable.

48. A POSITA, when reading an equation or an algorithm disclosed in an invention or a peer-reviewed scientific paper, would need to find out the possible values that such a variable (e.g. T) can take, either as a limiting range of acceptable values or some specific design choice values which would make its use advantageous. Without such disclosure, a POSITA would find the solutions taught in the invention or paper impossible to achieve. More specifically, in the context of computer instructions that need to be programmed to effect a disclosed solution or algorithm, such as the frequency hopping algorithm described in the '346 patent, variable values must be specifically defined to generate an operable code. In other words, if a POSITA were to attempt to write processor/computer code for implementation of the '346 patent's claimed frequency hopping algorithm, it would be necessary for the POSITA to know before designing and writing such a programming code what the time period T is intended to be in terms of a range of values or specific value(s).

49. A POSITA would not have understood the time period T to be independent of the claimed frequency hopping algorithm. If the time period T is not an aspect of the frequency hopping algorithm itself, and instead is not limited at all, it would not need to have been recited in the claim at all. A POSITA, certainly, would not have understood these claims to allow the time period T to cover ***any*** arbitrary time period that the patent owner might, after the fact, choose for T. A construction of the time period T that does not actively exclude arbitrary, after-

the-fact interpretations would fail to inform a person of skill in the art what the limits of the claim are and how one might avoid the claim. If the patent owner were to attempt to claim that the period T could be ***any*** unlimited time period, a POSITA would not have known how to evaluate an algorithm to determine whether it fits within the scope of the claim or not. This situation would also be unreasonable because an unlimited time period has no connection to the '346 patent specification or its purported invention.

50. In contrast to an completely unrestricted time period T, a POSITA would, however, have understood the term "time period T" based on the algorithm disclosed in the intrinsic evidence of the '346 patent to be "a pre-set amount of time for one cycle of frequency hopping, which is no longer than the amount of time it would take to use each channel available for frequency hopping once."

51. A POSITA reading the claims would have understood that the claims require that the time period T be no shorter than two frequency bursts, as there must be a "subsequent selection" of a second frequency during "at least a portion of the time period T."

52. To understand the reasonable upper bounds of the time period T, a POSITA needs to rely on the disclosure of the '346 patent. As I explained in the Summary of the '346 Patent section above, the patentee consistently explained that the invention is limited to a specific algorithm in which a frequency cannot be repeated during one time period T, *e.g.*, the amount of time it takes a frequency hopping system to use each available channel for frequency hopping once. As explained, the patent says that this algorithm is necesssary to solve the problem that prior art pseudorandom frequency hopping systems did not "***guarantee fading diversity (i.e., no frequency repetitions) within the interleaving depth*** of a speech frame." *See, e.g.*, '364 patent at 1:55-59.

53. A POSITA reading the '346 patent would have understood this to mean that it would have been necessary for a frequency hopping system to set the time period T to a pre-set amount of time for one cycle of frequency hopping, which is no longer (i.e., equal to or less) than the amount of time it would take to use each channel available for frequency hopping once in order to solve this alleged problem in the prior art.

54. They also would have understood that if the "time period T" is not limited to this meaning, they would have no way of knowing any upper bound of T, and the claims would not have had a definite plain and ordinary meaning. Furthermore, if T were longer than the amount of time needed to use every available frequency, the claimed algorithm would not have been able to control the hopping to prevent the frequency repeats that the patentee identified as the specific flaw in GSM "the invention" was designed to correct.

55. WSOU's "alternate" construction simply substitutes the words "time period T" to "period of time T," which does not change their meaning, and would not provide a definite plain and ordinary meaning to a POSITA.

56. In summary, it is my opinion that a POSITA would have understood the "time period T" terms to mean "a pre-set amount of time for one cycle of frequency hopping, which is no longer than the amount of time it would take to use each channel available for frequency hopping once."

B. The Hopping Sets of "N" and "F" Frequencies (All Asserted Claims)

57. On their own, the claimed "N" and "F" hopping frequencies would not have had a definite plain and ordinary meaning to a POSITA at any time, including in 2001. This is because, for the same reasons I explained for the "time period T" terms above, they are nothing more than undefined notational variables that have no inherent meaning.

58. The fact that certain claims state that "N is the total number of frequencies available for hopping" does not remedy this lack of an ordinary meaning. This is because, in the abstract, this phrase gives a POSITA no way of knowing what it means to be "available for hopping." For example, the claims give no guidance as to whether N refers to any or all of: 1) all frequencies in nature; 2) all frequencies allowed by government regulations; 3) all frequencies available to a particular communications standard; or 4) all frequencies currently being used for hopping according to the claimed algorithm.

59. A POSITA would, however, have understood the what the claimed "N" and "F" hopping frequencies are after reviewing the intrinsic evidence of the '346 patent. A POSITA reading the '346 patent specification and its prosecution history would have understood that: 1) "N frequencies," "a set of hopping frequencies," and "a hopping set" *are* "a pre-configured number of distinct hopping frequencies to which the hopping constraining algorithm is applied and which must not be selected more than once over the time period T"; and 2) "a size of F frequencies," "a set of F frequencies," "a hopping set to a size of F frequencies," and "a hopping set comprising F frequencies" *are* "for a time period T, the number of remaining frequencies available for frequency hopping that have not been previously selected during that time period."

60. As I explained in the Summary of the '346 Patent section above, the patentee consistently explained that the invention is limited to a specific algorithm in which a frequency cannot be repeated during one time period T, *e.g.*, the amount of time it takes a frequency hopping system to use each channel available for frequency hopping once. As explained, the patent says that this algorithm is necesssary to solve the problem that prior art pseudorandom frequency hopping systems did not "***guarantee fading diversity (i.e., no frequency repetitions) within the interleaving depth*** of a speech frame." *See, e.g.*, '364 patent at 1:55-59.

61. A POSITA reading the '346 patent would have understood this to mean that it was necessary to have a frequency hopping system that sets N to a pre-configured number of distinct hopping frequencies to which the hopping constraining algorithm is applied and which must not be selected more than once over the time period T in order to solve this alleged problem in the prior art. *See, e.g., id.* at 7:20-34 (explaining that an algorithm using N according to this definition is necessary to accomplish cycling through every one of N available frequencies once during a time period T in order for the claimed "use of constrained frequency hopping [to] allow[] … pseudo-random frequency hopping to achieve full fading diversity" and "maximize[] the number of unique frequencies that occur over the interleaving depth of a speech frame," as necessary to achieve the "ideal," "fully realized" version of frequency hopping claimed in the '346 patent).

62. A POSITA also would have understood that if "N" is not limited to this meaning, they would have no way of knowing what N means, and the claims would not have had a definite plain and ordinary meaning.

63. Indeed, the '346 patent explains that N has to be the pre-configured set of frequencies that is specified by the hop constaining algorithm and used for a session of frequency hopping, because it is necessary to use such a pre-configured set in order to track all of the frequencies over the time period T and make sure each is prohibited after being used.

64. The '346 patent also defines N in a manner that is narrower than all possible frequencies allowed in nature or by a particular wireless standard, because it explains that when its algorithm is used with the GSM standard, N can be a smaller than the total number of frequencies allowed by GSM and, in fact, is less useful when N is larger. *See* '346 patent at 3:38-56.

65. The same is true of F, which must be considered together with N. A POSITA reading the '346 patent would have understood F according to its definition in the patent as the number of remaining frequencies available for frequency hopping that have not been previously selected during that time period.

66. F has to be limited to this meaning – as a subset of N that is decremented each time a frequency is selected until it reaches 0, at which time every available frequency has been selected exactly once during the time period T – in order to solve the purported "frequency repetition" problem in the prior art. *Id.* at 3:57-65; 5:55-60; 6:29-33; *see also* 5:21-27, 5:42-55; 7:20-34. If "F" is not limited to this meaning, a POSITA would have no way of knowing what F means, and the claims would not have had a definite plain and ordinary meaning.

67. Additionally, a POSITA reading the prosecution history of the '346 patent would have seen that when the patent owner amended the claims to require that "at least one of the selected frequencies is prohibited from subsequent selection in at least a portion of the time period T" selection, they also argued that neither of the Munday or Haartsen prior art references teach this concept because, "after a set of frequencies is selected in Munday or Haartsen any frequency within the set can be re-selected without prohibition. Said another way, neither Munday nor Haartsen is prohibited from re-selecting a frequency, from a set of allowable frequencies, that has already been selected during a time period, T, as in the claims of the present invention." *See* April 5, 2005 Request for Reconsideration pp. 2-12; *see also* April 5, 2005 Notice of Appeal pp. 17-18.

68. A POSITA would read this statement by the patent owner together with the claims as a whole, and would have understood them to also be saying that Munday and Haartsen lack an "N" and "F," as defined in the '346 patent specification. This is because, without

limiting the claims so that "N" and "F" (and "T") are defined by the specification, the "subsequent" limitation would not recite a way to effectively prohibit a frequency from being re-selected during the time period T. In other words, if the "N" or "F" terms are construed in a way that would allow a frequency hopping system to select any frequency more than once during a particular time period T, prior art systems like Munday or Haartsen would cover the claims.

69. In summary, it is my opinion that a POSITA would have understood "N frequencies," "a set of hopping frequencies," and "a hopping set" to mean "a pre-configured number of distinct hopping frequencies to which the hopping constraining algorithm is applied and which must not be selected more than once over the time period T." They also would have understood "a size of F frequencies," "a set of F frequencies," "a hopping set to a size of F frequencies," and "a hopping set comprising F frequencies" to mean "for a time period T, the number of remaining frequencies available for frequency hopping that have not been previously selected during that time period." If these terms are not limited to these meanings, the claims would not have had a definite plain and ordinary meaning to a POSITA.

C. "At Least One of the Selected Frequencies is Prohibited from Subsequent Selection" (All Asserted Claims)

70. I was not asked to render an opinion on this term.

D. "Pseudorandom[ly]" (All Asserted Claims)

71. In view of the intrinsic and extrinsic evidence, a POSITA at the time of the '346 patent's alleged priority date would have understood the term "pseudorandom[ly]" to mean "a selection generated by an algorithm that approximates a random selection by avoiding a regular pattern of selections when the algorithm is used repeatedly."

72. A POSITA would have come to this understanding based on the '346 patent's explanation of the objectives of the patent's purported invention, the patentee's characterization

of the prior art in the prosecution history, and the ordinary definitions of the term in contemporaneous dictionaries.

73. As a preliminary matter, a POSITA would not consider WSOU's "alternate" construction, "appears to be patternless," to be acceptable. One reason for this is because a selection that merely "appears" to be patternless, as opposed to actually being patternless, would encompass subject matter that is not "pseudorandom." One example of a selection that might "appear" to be patternless but is not pseudorandom is the selection of a single number, because one selection cannot form a pattern. Another example of a selection that might "appear" to be patternless but not actually be would be the series of selections of the string of digits 076923. While these digits alone might "appear" random, a POSITA would understand that they are not actually random, as this digit string is created by dividing 1 by 13, which is 0.076923076923…, where the digits 076923 repeat forever. Neither of these selections that "appear" random are part of a pseudorandom algorithm.

74. As I explained in the Summary of the '346 Patent section above, the '346 patent purports to have solved the problem that prior art pseudorandom frequency hopping systems did not "***guarantee fading diversity (i.e., no frequency repetitions) within the interleaving depth*** of a speech frame." '345 patent at 1:55-59.

75. Thus, a POSITA reading the '346 patent would have understood that a frequency hopping system that uses a pseudorandom selection algorithm that does not allow any frequency repetition within a speech frame would have been necessary, in the context of the '346 patent, in order to solve this stated problem in the prior art.

76. Additionally, a POSITA reading the prosecution history of the '346 patent would have seen that when the patent owner amended the claims to require "pseudorandom" selection,

they also argued that the Kung prior art reference "teaches away" from pseudorandom selection "by cycling through an ordered frequency set in a predetermined fashion," and that the Emi prior art references "teaches away" because it substitutes a frequency with a high error count with an alternative, unused frequency. *See* August 16, 2004 Amendment pp. 2-8, 11.

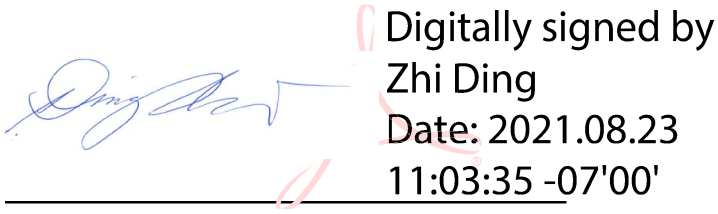
77. Emi and Kung both disclose frequency hopping systems in which there are selections that "appear" to be patternless. For example, Emi substitutes frequencies on channels with high error counts with channels with low error counts while the system is in use in a manner that "appears" patternless, because frequencies with higher error count would generally vary when channel conditions vary ***and*** because the frequencies selected to substitute those high-error channels (frequencies) at any given time may vary as well. Similarly, two selections in Kung in isolation may "appear" to be patternless, when in fact they are part of a predetermined pattern. Accordingly, a POSITA would have understood the patent owner to be saying that systems using algorithms that may "appear" to be patternless, like Emi and Kung, are outside of the scope of the claims, and only systems that actually avoid a regular pattern of selections when an algorithm is used repeatedly are within the claims.

78. This understanding that a pseudorandom selection is an active selection made as part of an algorithm that actively avoids a pattern by design, and not a selection that merely "appears" random is confirmed by contemporaneous dictionary definitions. For example, the 2000 American Heritage College Dictionary defines "pseudorandom" as "of, relating to, or being random numbers generated by a definite nonrandom computational process," and the 2001 Webster's II New College Dictionary defines "pseudorandom" as "of, pertaining to, or being random numbers generated by a definite, nonrandom computational process." This is further confirmed by the definitions of the more general term "random" in the same dictionaries, which

reiterate that to be random, there must actually be no pattern, and not simply the appearance that there is not one. *See* The American Heritage College Dictionary (2000) (defining "random" as "having no specific pattern, purpose, or objective"); Webster's II New College Dictionary (2001) (defining "random" as "having no specific pattern, purpose, organization, or structure" and "of or designating a phenomenon that does not yield the same results every time it occurs under identical circumstances").

79. In summary, it is my opinion that a POSITA would have understood the term "pseudorandom[ly]" to mean "a selection generated by an algorithm that approximates a random selection by avoiding a regular pattern of selections when the algorithm is used repeatedly."

I declare under penalty of perjury that the foregoing is true and correct. Executed on August 23, 2021, in Davis, CA.



Dr. Zhi Ding